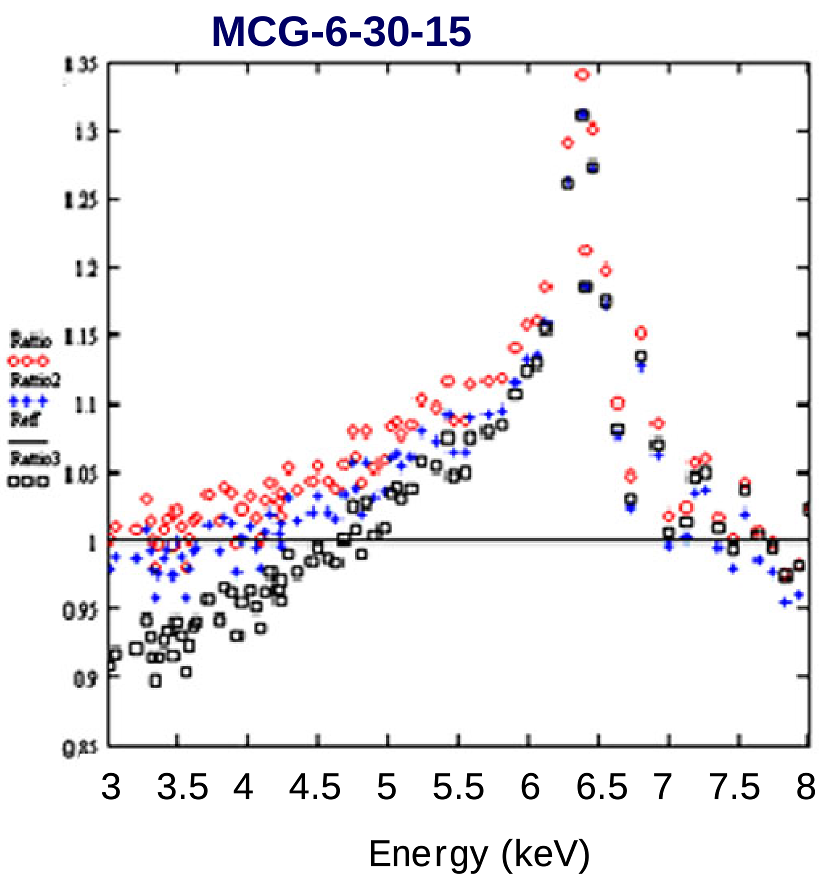
HXT Status update for Con-X

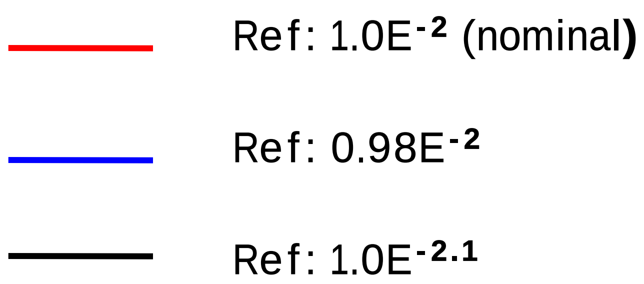
Suzanne Romaine

Several HXT Scientific Objectives

- Observe simultaneously with the SXT and measure the intensity and spectral function of the continuum (in the region that includes an SED maximum) for unambiguous interpretation of gravitationally redshifted, broadened Fe lines emitted by SMBH’s, stellar mass black holes and neutron stars.
- Resolve a large fraction of the hard X-ray background
- Study non-thermal emission processes generally, including particle acceleration in SNRs
- Hard X-ray survey of the galactic center and regions of the plane
- Aid search for optically identifiable black hole candidates in face-on nearby galaxies by detecting hard spectral components
- Map possible extended hard X-ray emission in clusters of galaxies
- **…(more)**
- **N.B. In pointed measurements the HXT is two orders of magnitude more sensitive than all hard X-ray instruments in space to date including OSSE, INTEGRAL and the Swift BAT**

Effect of continuum uncertainty upon profile of gravitationally redshifted, broadened Fe line (observed by Minuitti et al., 2006)



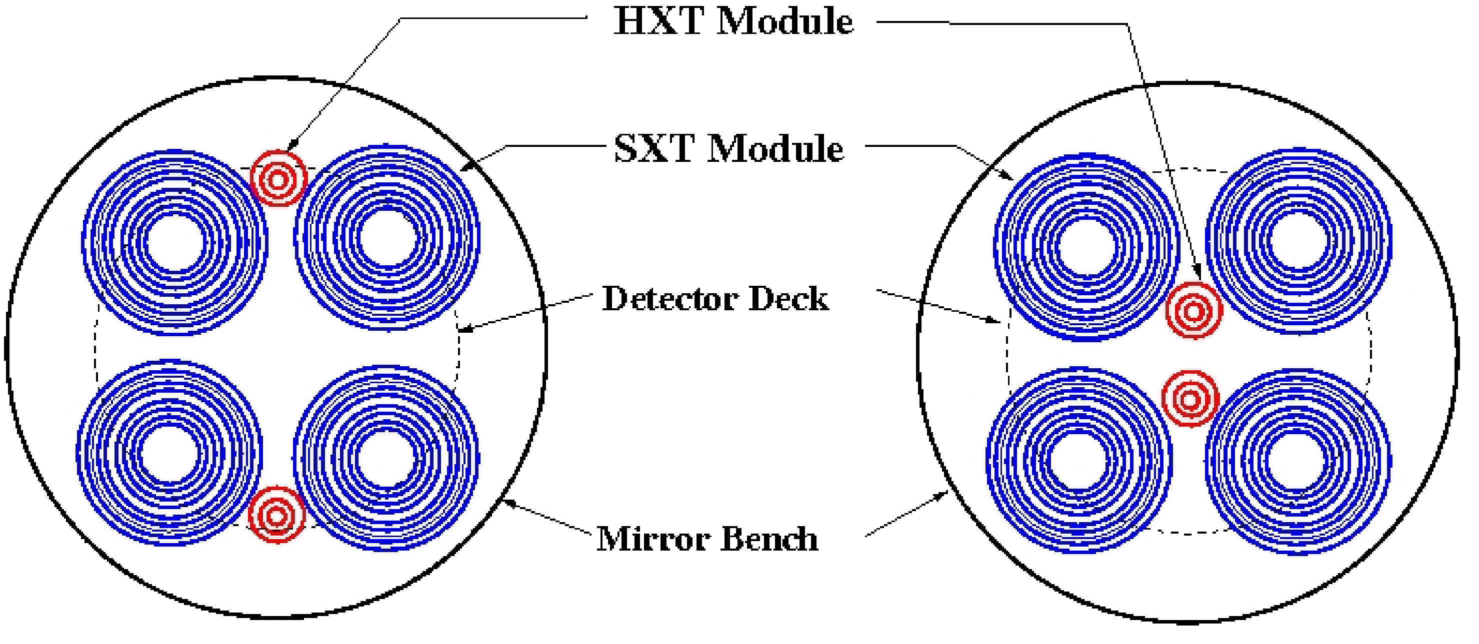


Small uncertainties in the amplitude or functional form of the continuum result in significant uncertainties in the shape of the gravitationally redshifted and broadened Fe line.

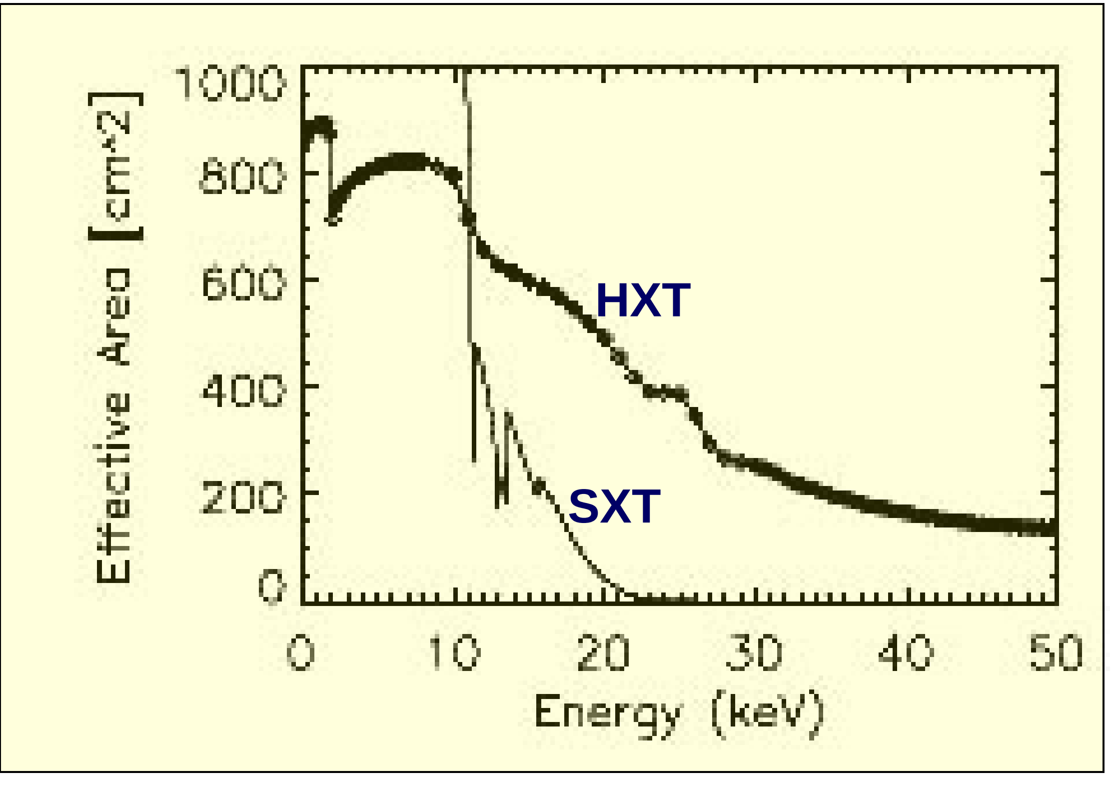
The HXT “Enhancement Package”

- RFI issued in 2006 for SEP which included HXT
- Stricter cost and mass limits of -> 100 kg & 100M$
- Single S/C with 4 SXT modules

Possible HXT 2-module Configurations



Theoretical Effective Area of a 2-module HXT design



Design Parameters

68 nested shells
10 m focal length
i.d. = 15 cm
o.d. = 34 cm
Shell length = 60 cm
Iridium coating inner
W/Si coating outer

HXT Performance requirements

Parameter	Value
Bandpass	6 – 40 keV
Field of View	5 arcmin
Spectral Resolving Power	> 10 **(FWHM, E/ΔE)**
Effective Area	150 cm^2 (6-40 keV)
Angular Resolution (HPD)	30 arcsec

Possible technologies for HXT Optics

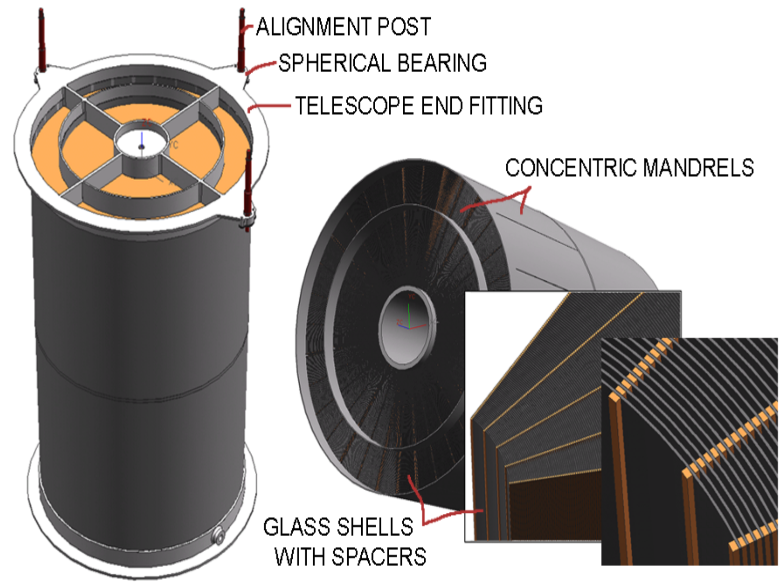
- **Thermally formed glass segments** – Heritage => HEFT, NuSTAR :

  CalTech, GSFC,Columbia,LLNL,DNSC (F.Harrison,W.Zhang, C.Hailey, B.Craig,F.Christensen)
- **Nickel replicated shells** - Heritage => XMM-Newton, Swift, HERO,SIMBOL-X :

  SAO,MSFC, Brera Obs. (P.Gorenstein,B.Ramsey,G.Pareschi)
- both tech. are making progress by leveraging other programs

Baseline Optics Parameters and Design (glass)

Parameter	Description
Design	Segmented conical approx.
Substrate material	Thermally formed glass
X-ray reflecting surface	Pt/SiC & W/SiC multilayer
Number of shells/mirror	130
Reflector length (mm)	450
# azimuthal segments	6, 12
Inner, outer mirror radius (mm)	55, 195
Reflector thickness	0.21 mm
ML interface roughness (nm)	0.35 (W/SiC) 0.45 (Pt/C)



Current Status glass HXT

- Adoption of GSFC Constellation-X glass forming approach for NuSTAR
  - Increases yield from 40% to 95%
  - Reduces number of segments in telescope by factor two

NuSTAR angular resolution
- 1 arcmin (requirement), 40 arcsec (goal)

current GSFC glass segments ~ 30 arcsec resolution

HEFT mounting technique ~ 8 arcsec

Expect to meet HXT requirements of 30 arcsec

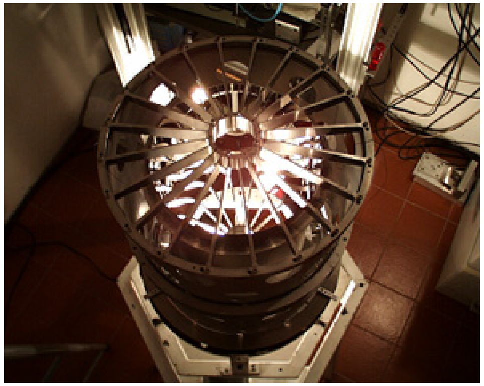
Baseline Optics Parameters and Design (nickel)

Parameter	Description
Design	Integral shells Wolter 1 geometry
Substrate material	Nickel
X-ray reflecting surface	Iridium & W/SiC multilayer
Number of shells/mirror	68
Reflector length (mm)	600
# azimuthal segments	1
Inner, outer mirror radius (mm)	150, 340
Reflector thickness	0.12 mm
ML interface roughness (nm)	0.4

Current Status of The Nickel HXT

Several mirror shells with 10 m focal length (42.6 cm long) with diameters ranging from 15 cm to 27 cm, shell thickness 100 microns were fabricated and coated

One or two shells at a time were integrated into the structure and tested at the 130 m Panter X-ray beam facility. Typical results in table below:



Energy (keV)	HEW (arc sec)
1.49	26.7
4.51	29.2
6.40	30.1
8.04	30.8

Properties Table

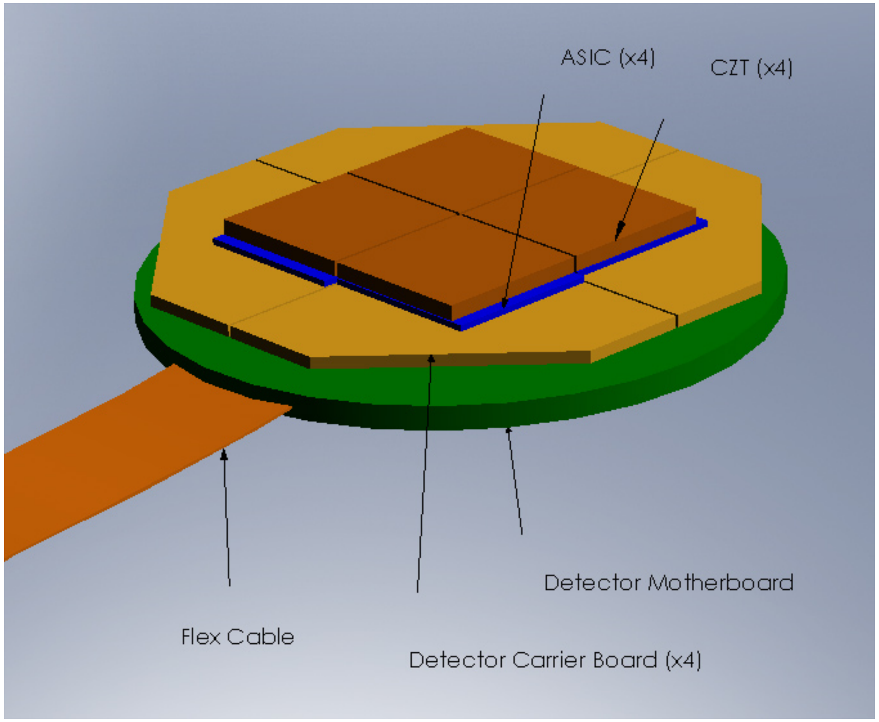
Property	Glass	Nickel
#shells/module	130	68
# segments/module	~ Two thousand ?	68
process	Thermally formed segments	Electroformed shells
Effective area	Exceed req	Exceed req
Mass	Meet req	Meet req
Ang. resolution	30” goal	30” measured

HXT - CZT Detector Properties
(same detector glass or nickel optic)

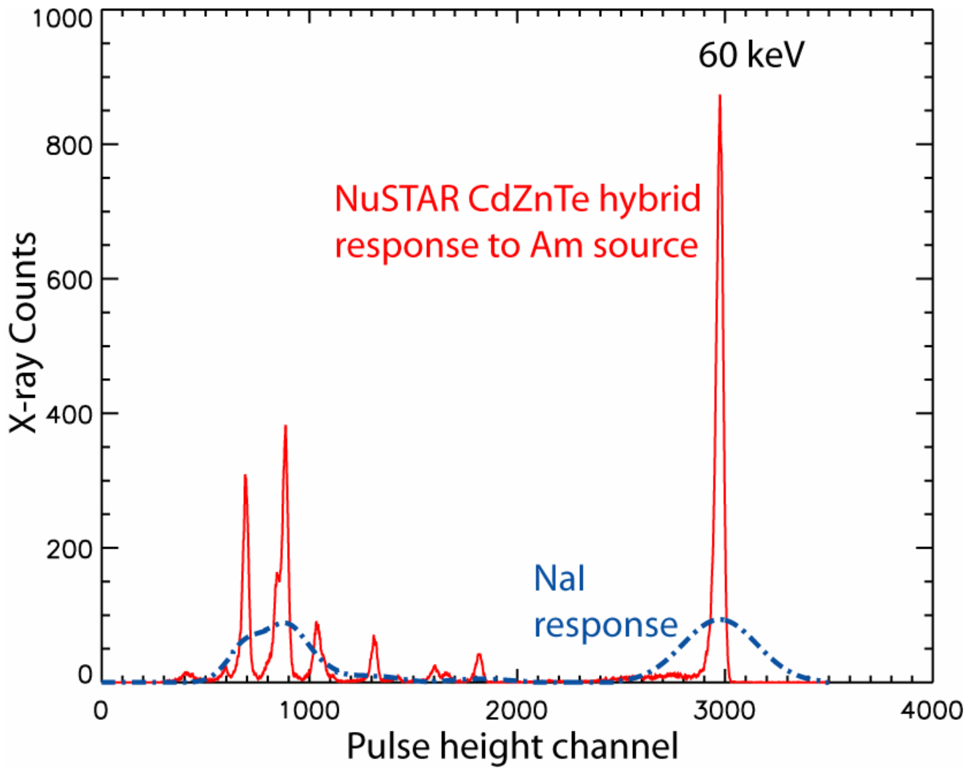
Parameter	Value
Number of pixels	44x44
Pixel size	500 microns
Energy Range	6 – 100 keV
Energy Resolution	< 1 keV FWHM
Intrinsic quantum efficiency	95 percent
Operating temperature	0 degrees C

CZT Detector Assembly
(being developed for NuSTAR)

- 2 by 2 CZT detector array
- Design will be modified for HXT



CZT Detector Performance



Plans - HXT

– An AO will be issued for instrument selection and will be the ultimate selection process for HXT. The timing will depend on the availability of funds.

- There is currently no funding available to support HXT tech. dev

However…
Glass optics leveraging NuSTAR
Nickel   ? monitor SIMBOL-X

END

Current Status of Nickel HXT

We noted that the resolution of several mirror shells were better than 20 arc seconds as measured with a mechanical profiler at MSFC prior to integration with the structure. This is considerably better than the ~ 30 arc second resolution measured at Panter following integration into the structure.

This is contrary to the experience of the HERO balloon program where the mechanical profile measurements have been a good predictor of the resolution after integration.

Since then we identified an effect in the Con-X integration procedure that accounts for the discrepancy between the before and after resolution. It can be corrected; we are confident that the angular resolution of new shells will be much better after integration.